U. S. FRUIT AND VEGETABLE PRODUCTS LABORATORY

WESLACO, TEXAS

A Bibliography
of
Publications

With Abstracts

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An Abstract Bibliography of Publications by the U. S. FRUIT AND VEGETABLE PRODUCTS LABORATORY, WESLACO, TEXAS

Compiled and Edited
by
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SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

For purposes of research by the U. S. Department of Agriculture on utilization of agricultural crops, the country has been divided into four regions. Each region is served by a Utilization Research and Development Division of the Agricultural Research Service. The Southern area includes Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, and Texas. Headquarters for the Division are located at:

Southern Regional Research Laboratory
1100 Robert E. Lee Boulevard
New Orleans, La.

This laboratory conducts research on utilization of cotton, cottonseed, rice, tung, peanuts and other oilseeds, sugarcane and sugarcane products, and sweetpotatoes, and on fundamental chemistry and process engineering and development applicable to utilization of these crops. Five field stations in the Division are located near sources of supply of the raw materials being studied, including citrus and other subtropical fruits, pine gum and its derivatives, and cucumbers and miscellaneous southern-grown vegetables. These field stations are:

U. S. Sugarcane Products Laboratory, Houma, La.
Naval Stores Station, Olustee, Fla.
U. S. Fruit and Vegetable Products Laboratory, Winter Haven, Fla.
U. S. Food Fermentation Laboratory, Raleigh, N.C.
U. S. Fruit and Vegetable Products Laboratory, Weslaco, Tex.

For information on any of the lines of research being conducted in the Southern Utilization Research and Development Division, you are invited to write or visit the Southern Regional Research Laboratory, or the field station immediately concerned with the product in which you are interested.

THE U. S. FRUIT AND VEGETABLE PRODUCTS LABORATORY
Weslaco, Texas

The U. S. Fruit and Vegetable Products Laboratory at Weslaco, Texas, now a part of the Southern Utilization Research and Development Division of the Agricultural Research Service, U. S. Department of Agriculture, is one of three such laboratories established by the Department during the 1930's to study the processing and utilization of southern fruit and vegetable crops.

The Weslaco Laboratory was authorized by Congress in 1931 in response to requests by the infant citrus industry of South Texas for help in developing processed products in correlation with fresh fruit production. Workers there in the early years of the Laboratory contributed materially to the establishment and growth of the citrus canning industry in that area.

For more than a decade this industry consisted largely of canning juice from white grapefruit. After introduction of first pink, and later red grapefruit, however, the trend in plantings shifted from white to the colored varieties. Increased production of the pink and red grapefruit brought its own problems, because juices from this type of fruit could not be processed satisfactorily by the methods used for canning of juice from the white fruit.

Investigations of the chemistry and processing technology of red and pink grapefruit constitute the principal research activities of the Weslaco Laboratory. One of the earliest contributions resulting from these investigations was the development of a method for canning single-strength juice with a natural pink color, provided by addition of small quantities of the finely-divided colored pulp to the extracted juice. Promising as the pulp-fortified, single-strength juice appears as an outlet for pink and red grapefruit in surplus supply, or unsuitable for sale as fresh, it is not regarded as the ultimate answer to the Texas grapefruit utilization problem. To provide a basis for development of other kinds of products from colored fruit, studies were initiated on the origin, nature and chemistry of the carotenoid pigments responsible for the grapefruit color. This work has already resulted in several publications on the chemistry of these pigments, and on the seasonal development and decline of color.

Progress has also been made by scientists at the Weslaco Laboratory in their study of bitterness in grapefruit, and its removal. Recently members of the technical staff at

the Weslaco Laboratory have used grapefruit juice as the base for some very pleasant-tasting fruit drinks by the addition of blackberry, strawberry, and other fruit essences or purees, and are pursuing this investigation still further.

Although the original purpose of the Weslaco Laboratory was primarily the study of citrus products, other food crops are also investigated. For example, there is an interest in avocados as a crop for the Southern United States. This has brought a demand for processed products to utilize surplus and edible fruits which do not meet fresh market standards. Weslaco research has succeeded in developing an avocado salad base that keeps well in frozen storage in laboratory tests. The Laboratory's program has also been expanded to include the processing of many of the vegetables grown in the South, such as tomatoes, Southern peas (blackeye, purple hull, crowder, and cream), snap beans, carrots, and others. The Laboratory works closely with the Texas Agricultural Experiment Station and local industry, especially on the evaluation of the processing qualities of breeding selections, newly released varieties of fruits and vegetables, and on adapted varieties as influenced by cultural practices and other environmental factors.

The accomplishments of the Weslaco Laboratory are reported in the various publications listed and abstracted in this compilation. Reprints are no longer available for many of the earlier papers. Most of those of technical interest can, however, be seen in the journals in which they were published.

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2412. PRODUCTION OF PULP FORTIFIED CONCENTRATE FROM RUBY RED GRAPEFRUIT - A PROGRESS REPORT. Tucker, D. M. and Lime, B. J. J. Rio Grande Valley Hort. Soc. 16: 112-20. 1962.

Mid season and late season packs (1960-61) and an early season pack (1961-62) of pulp fortified red grapefruit juice concentrates were prepared, stored, and evaluated for color, cloud retention and taste. The improvement of the color of the reconstituted concentrate by the use of high pulp cutback juice in the preparation of the concentrate was repeatedly demonstrated. The addition of this pulp had an adverse effect on cloud retention which could be overcome by heat treatment of either the low pulp evaporator feed juice (mid season) or the heat treatment of both the low pulp evaporator feed juice and the high pulp cutback juice (early and late season). The addition of this pulp also caused gelation which could be overcome by heat treatment of either the low pulp evaporator feed juice or the high pulp cutback juice, or both. There was no apparent detrimental effect on taste due to the heat treatment necessary to offset the adverse effect on cloud and gelation of addition of high pulp cutback juice. Due to the freeze of January 9-12, 1962, which prevented a full season's work, these observations should be rechecked through another season under carefully controlled conditions, when normal fruit becomes available.

2411. SEASONAL VARIATION IN TEXAS HAMLIN AND MARRS ORANGE JUICE. 1961-62 Lime, B. J. and Tucker, D. M. J. Rio Grande Valley Hort. Soc. 16: 78-82. 1962.

The variation in juice quality of Texas-grown Hamlin and Marrs oranges is reported. The low acid, Brix and color values noted for juice from Hamlin oranges indicates that a high quality juice product could be prepared from this variety only by blending a large quantity of juice from another variety such as Valencia. Although the data obtained from the juice from Marrs oranges shows higher Brix and color values, the low acid values would indicate that this variety should also be blended with a variety such as Valencia. The juice yield, citric acid content, and ascorbic acid content of the oranges decreased rapidly after the January 12 freeze. Hamlin and Marrs, the more mature varieties on this date, showed the greatest loss, while Valencia, a later maturing variety, had the smallest percent of decrease.

2283. CAROTENOIDS OF GOLDRUSH SWEETPOTATO FLAKES. Purcell, A. E. Food Technol. 16: 99-102. 1962.

The major carotenoid pigments were investigated in raw Goldrush variety sweetpotatoes, in cooked puree, and in precooked dehydrated flakes stored at both freezing and ambient temperatures. Seven pigments constituted 98 percent of the total pigments: phytoene 2.6 percent, phytofluene 0.8 percent, β-carotene 89.9 percent, zeta-carotene 1.2 percent, β-carotene-5,8-epoxide 2.5 percent, γ-carotene 0.7 percent, and hydroxy-zeta-carotene 0.5 percent. No α-carotene was found. The relative amount of the individual carotenoids did not change appreciably during processing of sweetpotatoes into flakes or during storage of the flakes. Carotenoids were apparently not destroyed in processing. Antioxidant added to the flakes, storage under nitrogen, and storage at low temperature decreased losses of carotenoids in storage.

2282. HOME PREPARATION OF CITRUS DRINK CONCENTRATES. Lime, B. J. and Griffiths, F. P. Texas Farming & Citriculture 38: (8): 26-B. 1962.

Formulations for fruit juice bases or punch concentrates are given which use commercially available canned fruit juices. Grapefruit juice 2 quarts, lemon 1-½ quarts, blackberry 16 ounces, and sugar 5 pounds makes a blend which, when diluted with 3 volumes of water and ice, gives a satisfactory party drink. Other formulations are discussed.

2232. BIOSYNTHESIS OF STIGMASTEROL IN TOMATO FRUITS. Bennett, R. D.; Heftmann, Erich; Purcell, A. E.; and Bonner, James. Science 134: 671-72. 1961.

The presence of stigmasterol in tomato fruits was demonstrated. Labeled mevalonic acid was incorporated into this sterol, while sodium acetate was not. The identity of the isolated product was established by vigorous purification to constant specific activity, melting point determinations, and infrared spectrum.

2215. A LABORATORY MODEL ROTARY SCREEN GRADER FOR SOUTHERN PEAS. Stephens, T. S. J. Rio Grande Valley Hort. Soc. 15: 94-98. 1961.

A laboratory model rotary screen grader for Southern peas has been constructed. The size openings of the screens and the operation of the machine has been adjusted to consistently separate Southern peas, California Blackeye No. 5, into sizes 0 to .175, .175 to .200, .200 to .225, .225 to .250 and .250 and larger inches in diameter.

2214. OBSERVATIONS ON THE COLOR OF RED GRAPEFRUIT SEEDLINGS. Purcell, A. E. and Hensz, Richard. J. Rio Grande Valley Hort. Soc. 15: 78-79. 1961.

The color of fruit produced by 5-6 year-old Webb Redblush grapefruit trees was compared to the color of fruit produced by "old line" Ruby red grapefruit trees. Color of fruit was compared September 1, and December 30, 1960. Differences were noted on both dates, but in all samples except one the differences were less than between pink and red varieties. One tree bore white fruit. Some of the fruit were less colored and some were more colored than "old line" fruit. Some fruit appeared to hold color late in the season better than "old line" fruit, while others faded more rapidly.

2213. SEASONAL VARIATION OF TEXAS VALENCIA ORANGE JUICE. Lime, B. J. and Tucker, D. M. J. Rio Grande Valley Hort. Soc. 15: 29-31. 1961.

The seasonal variation of the juice quality of Valencia oranges grown in Texas is reported. The same general trends due to seasonal variation were noted as reported from Florida Valencia oranges. Although this study covers only one season and fruit from two groves, the seasonal variation of juice quality should be applicable in predicting the variation that can be expected in other seasons from normal groves.

2183. GUACAMOLE SALAD (Suitable for Frozen Storage). Stephens, T. S. and Griffiths, F. P. Texas Farming and Citriculture 38, (2): 7A-8A. 1961.

Guacamole, an easily prepared avocado product, has been made which uses "cracker meal" as a thickening agent rather than waxy rice flour, sodium alginate or other thickening agents. Guacamole is a combination of avocado meat, lemon juice, onion powder, salt and cracker meal.

2165. GLUCOSE AS A CARBON SOURCE FOR CAROTENE SYNTHESIS IN TOMATOES. Purcell, A. E. and Thompson, G. A., Jr. Arch. Biochem. Biophys. 93: 231-37. 1961

Mevalonic acid provided to detached tomato fruits is the most efficient precursor of carotenoids yet reported. Much of the mevalonic acid is incorporated into a series of nonsaponifiable colorless compounds with chromatographic behavior the same as the known carotenes. Three carotenes, phytoene, β-carotene, and lycopene, which constitute about 88 percent of the carotenes of tomato fruit, have been freed from these contaminants, and ratios of incorporation of various substrates into carotenes and total nonsaponifiable materials can be calculated. Acetate is apparently incorporated via mevalonic acid. Glucose is a more efficient precursor of carotenes than acetate though less efficient than mevalonic acid, but only small amounts are incorporated into the unknown colorless compounds. Carbon dioxide is incorporated in about the same ratio as glucose. Glucose and carbon dioxide appear to be incorporated into carotenes through a 20-carbon precursor (3, 7, 11, 15-tetramethylhexadeca-1, 3, 6, 10, 14-pentaene) although the turnover rate is much faster than with mevalonic acid. It is suggested that the differences in the incorporation of mevalonic acid and glucose may be due to different sites of carotene synthesis within the cell.

2008. A CAROTENE PRECURSOR: ITS PROPOSED STRUCTURE AND PLACE IN BIOSYNTHETIC SEQUENCE. Thompson, G. A., Jr.; Purcell, A. E.; and Bonner, James. Plant Physiol. 35: 678-82. 1960.

A substance has been isolated from tomatoes which appears to be an intermediate in the pathway from mevalonic acid to the carotenes. The results of infrared spectroscopy and degradative studies indicate a probable structure of 3, 7, 11, 15-tetramethylhexadeca-1, 3, 6, 10, 14-pentaene.

2004. EVALUATION OF GREEN BEAN VARIETIES SUITABLE FOR PROCESSING. Stephens, T. S. and Correa, R. T. J. Rio Grande Valley Hort. Soc. 14: 149-68. 1960.

Evaluations of yield, pod characteristics and processed quality were made on 18 varieties and 7 strains of green beans for 1 to 6 seasons. According to these test the varieties Topcrop, Pearlgreen and Topmost are the most promising varieties and Corneli 14, Earligreen and Tenderwhite varieties have many desirable characteristics for a suitable variety in the Rio Grande Valley. Early maturing varieties or strains are desirable for fall planting because early frosts frequently damage the plants. Varieties and strains grown in the

fall matured pods 2 to 10 days earlier than the same varieties or strains grown in the spring. A fiber sheath developed in the walls of the pods of Seminole variety every season it was included in the tests. The percentage by weight of seed in the pods was neither an indication of maturity as measured by the fiber content of the pod, nor was it an indication of roughness of the pod.

2003. THE EFFECT OF ROW SPACING ON GREEN BEAN VARIETIES. Correa, R. T. and Stephens, T. S. J. Rio Grande Valley Hort. Soc. 14: 140-48. 1960.

The yields of beans used in these experiments were increased by 31 percent to as much as 130 percent by paired rows spaced 12 or 14 inches apart on 38-inch beds as compared to production from rows spaced 38 inches apart. The results of spacing beans in paired rows 6 inches apart on 38-inch beds were inconsistent with variabilities between varieties and seasons. These results indicate 12-inch spacing between rows is the minimum distance on which to obtain the highest production from Topmost, Pearlgreen and Tenderwhite. An intermediate spacing between 12 and 6 inches between rows is the most desirable for Topcrop, Harvester and Earligreen. Planting the rows of beans close together did not influence the sieve sizes of pods of Topcrop, Topmost, Pearlgreen or Tenderwhite. Neither did closer row spacing influence the percentage seed development nor fiber percentage of canned pods of sieve size 5 of Topcrop, Topmost, Pearlgreen or Tenderwhite. Harvester and Earligreen decreased in small sieve sizes, increased in large sieve sizes, and increased in percentage seed and fiber content of canned sieve size 5 pods from rows spaced 38 inches apart as compared to rows spaced 6 inches apart. A sensory evaluation of the canned pods by a panel of trained judges could not detect differences due to row spacing of Topcrop, Topmost, Pearlgreen or Tenderwhite.

2002. EFFECTS OF HEAT TREATMENT AND STORAGE TEMPERATURE ON SHELF LIFE OF CHILLED JUICES MADE FROM TEXAS CITRUS. Tucker, D. M.; Lime, B. J.; and Griffiths, F. P. J. Rio Grande Valley Hort. Soc. 14: 94-103. 1960.

Early season, mid-season and late-season packs of Texas grapefruit juice, orange juice and grapefruit-orange juice blends have been prepared, processed and stored at 32°, 40°, and 50°F., and the keeping time and quality determined. The advantages of 32°F. storage, both in keeping time and flavor quality, have been repeatedly demonstrated. Grapefruit, orange, and grapefruit-orange blend juices can be stored up to 21 days at 32°F. after heat stabilization treatments of 165°-180°F. Storage at 40°F. reduces keeping time in some cases to less than 14 days, even though higher temperatures, 170° - 180°F. are used for stabilization. When stored at 50°F., samples were spoiled in less than 14 days. In general, samples of all three juices had a higher flavor quality when stored at 32°F. than when stored at 40°F. Seasonal differences in the quality of the juice did not appear to greatly influence the length of time heat-stabilized juice could be kept.

2001. RAPID PROCEDURE FOR THE SEMI-QUANTITATIVE MEASUREMENT OF EXTERNAL D AND C RED NO. 14 DYE IN THE PRESENCE OF CITRUS RED NO. 2 DYE ON ORANGES. Lime, B. J. and Horspool, Raymond. J. Rio Grande Valley Hort. Soc. 14: 104-07. 1960.

A rapid method of determining the amount of External D and C Red 14 dye (m-xylylazo-2-napthol) present as a contaminant in Citrus Red No. 2 dye (1-(2,5-dimethoxy-phenylazo)-2-napthol). The total dye concentrations are determined colorimetrically from chloroform extracts of oranges. The extent of contamination is determined by comparing a developed paper chromatogram to a previously prepared standard chromatogram. The amount of Red 14 dye present in Citrus Red No. 2 can be estimated to within 5 percent.

2000. THE PRESERVATION OF PULP AND FORTIFICATION OF LATE SEASON POORLY COLORED RED GRAPEFRUIT JUICE. Lime, B. J. and Griffiths, F. P. J. Rio Grande Valley Hort. Soc. 14: 88-93. 1960.

A highly colored red grapefruit pulp, free of seeds and rag, was recovered early in the season from waste products of juice plant finishing operations by use of a brush finisher. Pulp was kept for three months in frozen storage or at room temperature after pasteurization without adverse effects on quality. Excess pulp, from the processing of red grapefruit juice, was recovered, stored, and successfully used to improve the color of canned single strength colored grapefruit juice under normal processing plant conditions, which indicates the commercial applicability of the process.

1999. QUALITY OF RED GRAPEFRUIT ON OLD-LINE GRAPEFRUIT VARIETIES ON XYLOPOROSIS- AND EXOCORTIS-TOLERANT ROOTSTOCKS. Cooper, W. C. and Lime, B. J. J. Rio Grande Valley Hort. Soc. 14: 66-76. 1960.

Although there are some striking differences in the effects of various rootstocks on the composition of the fruit, a relatively uniform rate of change occurred in the fruit on all rootstocks during the ripening period. In some years soluble solids remained more or less constant from October to January and then decreased slightly, while in other years the soluble solids decreased at a slow rate from October to March. In all years total acids were highest in October and decreased steadily through March. The red color of the juice decreased sharply and steadily with time from October until March for all rootstocks. Regardless of season and orchard, fruit on rough lemon rootstock was heavier, larger, thicker in rind, lower in acids and soluble solids, and deeper in red color of juice than fruit grown on the other rootstocks. The soluble solids and acids contents of the juice were similar for all other rootstocks. Although some differences in various physical characteristics of the fruit on these rootstocks occurred, they were in general small; and for all practical purposes, the fruit of trees grown on Cleopatra mandarin, Red Blush grapefruit, citrumelo 4475, and Uvalde citrange rootstocks had quality equal to that of fruit on trees grown on sour orange and superior to that on rough lemon rootstock.

1925. DETERMINING THE EFFECT OF RECIPROCAL GRAFTS OF RED AND WHITE VARIETIES OF GRAPEFRUIT ON THE ACCUMULATION OF CAROTENOIDS. Purcell, A. E. and Stephens, T. S. Proc. Am. Soc. Hort. Sci. 74: 328-32. 1959.

In studying the formation of the carotenoids in grapefruit an attempt has been made to determine if the chemical difference leading to an accumulation of larger amounts of pigment in the colored fruits is in the fruit, per se, or if it occurs in other parts of the plant. Short scions bearing young red fruits were grafted onto branches of trees of white fruited varieties, and vice versa. It was found that the characteristics of the fruits were not significantly changed by the variety of tree onto which the fruits were propagated. The results of this experiment indicate that the chemical difference leading to the accumulation of larger amounts of pigment in colored varieties is within the fruits.

1847. EVALUATION OF TOMATOES FOR PROCESSING IN THE LOWER RIO GRANDE VALLEY, SPRING 1958. Burns, E. E.; Leeper, P. W.· Stephens, T. S.; and Dacus, A. Texas Agr. Exp. Sta. Progr. Rept. No. 2104. 1959.

Named varieties and advanced breeding lines of tomatoes in the Lower Rio Grande Valley were evaluated for processing characteristics during the 1958 spring season. Yield, raw product grade and finished product grade information was compiled. Brix was a little higher, pH a little lower and acid slightly higher for tomato juice from the breeding lines than for the varieties and breeding lines used for whole canned tomatoes. The yield of breeding lines averaged about 10 tons per acre which was considered good. Strains W-275 and W-21-3 exhibited desirable characteristics for canned juice. Processed juice samples from all breeding lines, except W-11-3, were scored as "U. S. Fancy" on the basis of color. The addition of salt tablets containing calcium chloride had a marked effect upon maintaining the wholeness of the canned tomatoes. Tomatoes canned before the first week in June had much better color than those processed later.

1846. DEBITTERING OF GRAPEFRUIT PRODUCTS WITH NARINGINASE. Griffiths, F. P. and Lime, B. J. Food Technol. 13: 430-33. 1959.

Conditions of optimum enzymatic hydrolysis of naringin in grapefruit pulp and juice to less bitter substances, prunin and naringenin, are 50°C., pH 3.1, enzyme concentrations of .05-.01 percent and incubation periods of 1 to 4 hours. Enzyme action at a low temperature, 4°C. for 44 hours, hydrolysed naringin to less bitter prunin, without a corresponding decrease in Davis test value. Enzymatic hydrolysis of colored grapefruit pulp (.025 percent enzyme, 50°C., 1-½ hours) reduced bitterness and enabled the pulp to be used for color fortification of poorly colored, late season juice. Prior inactivation of pectinesterase naturally present in juice before naringinase treatment is necessary to retain natural cloud.

1749. VARIETY AND STRAIN EVALUATION OF SOUTHERN PEAS. Stephens, T. S. and Correa, R. T. J. Rio Grande Valley Hort. Soc. 13: 129-134. 1959.

Six varieties and 9 strains of Southern peas were grown in the spring of 1956 and 4 varieties and 11 strains were grown in the spring of 1957 and 1958. These varieties and strains were evaluated for yield, shell-out percentage and processing quality. The strain Purple Hull 13 and variety Purple Hull 49 were the most desirable of the blackeye-purple hull pea group and the strain Cream 16 was the best of the cream group, for the three seasons tested. Relatively large differences in seasonal shellout percentages are partly attributable to differences in maturity of the pods when harvested. A more rapid accurate method is needed to determine field maturity.

1748. SEASONAL DEVELOPMENT OF CAROTENE AND LYCOPENE IN GRAPEFRUIT. Purcell, A. E. J. Rio Grande Valley Hort. Soc. 13: 45-53. 1959.

The carotene and lycopene content of red, pink and white grapefruit was measured from a time shortly after the fruit formed until late in the processing season. During the four years for which data are available the lycopene concentration reached a maximum between August 15 and September 10. The carotene concentration continued to increase while the lycopene concentration decreased. The carotene concentration apparently does not reach a maximum during the same period each year. The decline of lycopene may be initiated by several factors, e. g., time since formation of the fruit, the photoperiodic effect of decreasing daylight or changes in temperature. In each of the four years recorded a slight decrease of temperature was noted during the period in which the decline began. Lycopene was found in white grapefruit. This indicates that the ability to synthesize lycopene did not originate by mutation of the white grapefruit to colored varieties. It does not necessarily indicate that the colored varieties have an increased ability to synthesize lycopene since the accumulation of the pigment may be explained by the loss of the ability to utilize carotenoid precursors or carotenoids, per se.

1746. PIGMENTATION, PIGMENT ANALYSES, AND PROCESSING OF COLORED GRAPEFRUIT. Griffiths, F. P.; Stephens, T. S.; Purcell, A. E.; and Lime, B. J. J. Rio Grande Valley Hort. Soc. 13: 30-38. 1959.

An increasing amount of Ruby Red and pink-fleshed grapefruit will become available for processing as orchards planted in the Lower Rio Grande Valley of Texas come into bearing. Because of lycopene and carotene pigments in this fruit special processing technics are advisable for the production of best quality canned grapefruit juice. Fortification of the juice with a maximum of pigment-containing pulp, intensifies the color, adds pro-vitamin A, and prevents dullness or muddiness developing in the canned product. Color of the fruit pulp varies from a bright red in the early immature fruit to a salmon pink in late season overmature fruit

and can be correlated with the ratio of lycopene over twice the carotene content, or with the a/b ratio as determined with a Hunter Automatic Color Difference Meter. Factors causing color variation of grapefruit are discussed. Two analytical methods for the determination of pigments present in colored grapefruit are outlined: A precise analytical chromatographic-spectrophotometric procedure for carotene and lycopene; and a more rapid spectrophotometric method in which the total pigment content is calculated as carotene and lycopene.

1744. THE INCORPORATION OF MEVALONIC ACID INTO TOMATO CAROTENOIDS. Purcell, A. E.; Thompson, G. A., Jr.; and Bonner, James. J. Biol. Chem. 234: 1081-84. 1959.

1. 2-C^{14}-labeled mevalonic acid is shown to be incorporated into a variety of carotenes by isolated tomato fruits. As much as 56 percent of the biologically active isomer appears in the carotene fraction in 24 hours of incubation. 2. All of the major carotenes, including lycopene, of isolated tomato fruits become labeled as the result of incubation of the fruit with C^{14}-labeled mevalonic acid. The specific activities of the individual substances are, however, very different. Phytoene has been found to have the lowest specific activity, phytofluene and ζ-carotene the greatest, of the major carotenes. 3. A major portion of the activity of 2-C^{14}-mevalonic acid appears in a hitherto unrecognized material, Fraction IIa. This material is closely associated with phytoene from which it is separated by chromatography on alumina. Fractions IIa and IIb possess absorption peaks at 208 and 231 mμ and presumably possess two conjugated double bonds. The kinetics of the appearance and disappearance of Fraction IIa suggest that it may be an intermediate in carotene biogenesis.

1743. CAROTENOID PIGMENT FORMATION IN COLORED GRAPEFRUIT. Purcell, A. E. J. Rio Grande Valley Hort. Soc. 13: 39-44. 1959.

In attempting to improve the processing quality of Texas colored grapefruit the biochemistry of the synthesis and degradation of the carotenoids has been studied. The lycopene (red pigment) concentration of Ruby Red grapefruit increases to a maximum before the fruit is ready for processing and then declines continuously. The factors responsible for initiating the decline of lycopene have not been determined. Lycopene also occurs in the pink and white variations of grapefruit and apparently follows the same seasonal trends. In following the seasonal distribution of lycopene in red, pink and white variations, lycopene appears earliest in the albedo of the red, and later in the carpels of the red and pink. Only traces of lycopene can be found in the albedo of the pink and white and in the carpels of the white. The distribution of lycopene in red fruit during the early stages of development is similar to the distribution of water-soluble dye entering the fruit from a cut stem. By grafting scions containing red fruit onto rootstock of a white variety and vice versa it has been shown that the rootstock does not change the color of the fruit. Apparently the chemical difference leading to the accumulation of carotenoids in the colored varieties is in the fruit

rather than in the rest of the tree. Biochemical studies of the specific chemical steps of carotenoid formation have shown that a relatively simple compound, mevalonic acid, is a precursor of the carotenoids as well as colorless materials which may be intermediates in carotene synthesis.

1667. INVESTIGATIONS ON THE BIOSYNTHESIS OF CAROTENOIDS IN THE TOMATO. Purcell, A. E. and Thompson, G. A. Proc. Ann. Meeting Am. Inst. Biological Sciences Plant Physiol. 33 (Supplement): 44. 1958.

Detached tomato fruits were injected with $1C^{14}$ acetic acid or $2C^{14}$ mevalonic (beta,8-dihydroxy, beta-methylvaleric) acid and allowed to ripen. Extraction of the nonsaponifiable fraction indicated that mevalonic acid was incorporated into this fraction on MGO columns revealed that about 70 percent of the radio-activity of that fraction in mevalonic injected fruit was present in the first eluate from the column. This eluate, upon further separation on alumina, produced phtoene and a 208μ absorbing compound having low activities and small amounts of a 231μ absorbing compound having a specific activity often as high as 100,000 cpm/mg. This latter compound seemed to accumulate at temperatures suboptimal for ripening. Dilution experiments and sparing effects of related compounds will be discussed. Degradation of the unknown compounds yielded fragments of the type to be expected from an isoprenoid structure. Much of the evidence favors the 231μ absorbing compound as being an intermediate in carotenoid biosynthesis.

1600. PRODUCTION OF CANNED PULP-FORTIFIED RED GRAPEFRUIT JUICE. Lime, B. J.; Stephens, T. S.; and Griffiths, F. P. U. S. Dept. Agr., ARS 72-12: 10 pp. 1958.

A high quality canned single strength pulp-fortified juice product possessing a distinctively red color may be made from red grapefruit by the proper adjustment of the pulp content as the processing season progresses. This adjustment serves to control depth of color and degree of bitterness. The pulp should be finely divided to give improved color and solids suspendibility to the product and to prevent a pulpy "taste." Red grapefruit should be processed separately from the pink and white varieties. The higher pulp content increases the yield of product per ton of fruit which should offset any additional processing cost.

1598. PARTITION SEPARATION OF CAROTENOIDS BY SILICA-METHANOL COLUMNS. Purcell, A. E. Anal. Chem. 30: 1049-51. 1958.

A method for partition chromatography of carotenoids is described. Petroleum solutions of carotenoids are passed through silica gel columns saturated with methanol. Three fractions can be obtained. The first fraction, which contains carotene hydrocarbons, is removed from the column with petroleum. The second fraction containing the monohydroxy carotenoids is removed with petroleum-ethyl ether, and the third fraction containing polyhydroxy carotenoids, is removed with methanol.

1596. THE EFFECT OF THICKENING AGENTS IN REDUCING THE WATERY SEPARATION OF FROZEN AND THAWED GUACAMOLE PRODUCTS. Stephens, T. S.; Lime, B. J.; and Griffiths, F. P. J. Rio Grande Valley Hort. Soc. 12: 81-87. 1958.

The use of waxy rice flour and sodium alginate, a product derived from kelp, was investigated for use as thickening agents to reduce or prevent the watery separation of frozen guacamole, an avocado product, upon thawing for table use. Waxy rice flour when used alone in high enough concentration to reduce watery separation, affected the flavor of the guacamole. By using a combination of waxy rice flour and sodium alginate the proportion of waxy rice flour could be reduced so that the flavor of the guacamole was not significantly affected, the watery separation of the product was reduced, and its consistency was stabilized if not actually improved. The waxy rice flour was folded into the mashed avocado flesh as a seasoned paste and in the formulas tested, resulted in a 20 percent increase in product volume.

1594. CONCENTRATE FOR LEMONADE FROM MEYER LEMON JUICE. Stephens, T. S. Citrus Ind. 39(1): 16-19. 1958.

It has been found that acceptable lemonade concentrate can be made from Meyer lemons by the addition of small quantities of oil of lemon to enhance the flavor. Methods of preparation and proportions of oil of lemon added are given.

1518. TEXAS PUNCH. Lime, B. J. and Griffiths, F. P. Texas Farming & Citriculture 34(4): 3. 1957.

The basic formula for a punch concentrate with four flavor variations has been presented with a view to providing an additional outlet for Valley grapefruit juice.

1515. SPECTROPHOTOMETRIC METHODS FOR DETERMINING PIGMENTATION-BETA-CAROTENE AND LYCOPENE IN RUBY RED GRAPEFRUIT. Lime, B. J.; Griffiths, F. P.; O'Connor, R. T.; Heinzelman, D. C.; and McCall, E. R. J. Agr. Food Chem. 5: 941-44. 1957.

Two methods for the measurement of pigments occuring in colored grapefruit are outlined and the results compared. Method A involves extraction of the sample, separation of the major pigments--lycopene and carotene--on a magnesia-Super Cel column, elution, and spectrophotometric measurements of the separated pigments. By method B, a more rapid but less precise procedure, the pigment is extracted and the absorptivity of the extract determined at 451 mμ for carotene and 503 mμ for lycopene. Results of total concentration of the pigments, as determined by simultaneous equations, show method B averages 10.3 percent higher for lycopene and 16.2 percent higher for carotene than method A. During a 69-day period, January 26 to April 4, lycopene, in the edible fruit of Ruby Red grapefruit, decreased from 0.29 mg. percent to 0.10 mg. percent, and carotene from 0.34 mg. percent to 0.21 mg. percent.

1443. PREPARATION OF A FROZEN AVOCADO MIXTURE FOR GUACAMOLE. Stephens, T. S.; Lime, B. J.; and Griffiths, F. P. J. Rio Grande Valley Hort. Soc. 11: 82-89. 1957.

Exploratory experiments were initiated to study such variables as yield of edible flesh, and the method, kind of packaging, and variety, as they affect the quality of an avocado product such as guacamole base. The first part of the experiment was conducted with a composite sample prepared from a blend of several varieties of avocados and packed in polyethylene bags and glass jars. The second part was intended to show the effects of variety or strain on the base. Samples from 12 varieties or strains of avocados were prepared and packed in 6-ounces plain tin cans. Samples packed in glass jars and tin cans were divided into thirds; from one third the air was withdrawn before containers were sealed; from another third air was replaced with nitrogen, and the final third was kept as a control. All samples were frozen and stored in still air at 0°F. Guacamole base kept well for seven months at 0°F. storage when packed in glass jars or tin cans. Samples in polyethylene bags were discolored and rancid at the end of three months. Edible portions of the varieties and strains tested varied from 71 percent to 40.6 percent. The Topa variety rated high for making guacamole base, and the C-3 and 21-6 strains were the poorest. The Y-7 strain made the most flavorful and best colored base, but was lowest in yield and most difficult to prepare.

1366. VEGETABLE PROCESSING PROBLEMS OF THE SOUTH TEXAS AREA: I. VALLEY'S TOMATO YIELDS TOO LOW. II. STAKING BEANS BEST. Griffiths, F. P. and Stephens, T. S. Texas Farming & Citriculture 33(3): 42; 33 (4): 20-21. 1956.

Problems of agronomy, disease, climate, water, and soil, in the Lower Rio Grande Valley of Texas are reviewed with consideration of their influence on quality and utilization of the crops. Principal canning crops are green beans, tomatoes, and beets. Lesser amounts of southern peas, carrots, okra, broccoli, cauliflower, and spinach are canned or frozen. Major needs are better color in tomatoes, firmer and higher yielding green beans, even-maturing and disease-resistant southern peas, carrots, okra, and spinach. Discoloration of canned beets is one of the processing problems.

1291. VARIETY AND STRAIN EVALUATION OF SOUTHERN PEAS. Correa, R. T. and Stephens, T. S. J. Rio Grande Valley Hort. Soc. 10: 90-95. 1956.

Sixteen varieties and new strains of southern peas were grown and evaluated for yield and processing quality. Commercial Purple Hull was the highest producer of green pod peas for the blackeye-purple hull group, and Cream 52 Sp 16 strain for the cream group. Drained weight and tenderometer values were compared in an effort to establish an instrumental measure of maturity, but no re-

lationship between tenderometer value, shellout percentage or drained weight was shown by this study. The canned peas were also evaluated for defects, splits, color, flavor, and appearance. Findings on all of these qualities are presented in tabular form.

1287. PROCESSING CHARACTERISTICS OF COLORED TEXAS GRAPEFRUIT. II. CORRELATION OF COLOR MEASUREMENTS AND PIGMENT ANALYSES OF RUBY RED GRAPEFRUIT. Lime, B. J.; Stephens, T. S.; and Griffiths, F. P. J. Rio Grande Valley Hort. Soc. 10: 53-63. 1956.

Reflectance measurements of the blended puree of Ruby Red grapefruit provide an index of seasonal variations of fruit color. The pigmentation of the puree measured as the ratio of total lycopene to twice the carotene value agrees well with the Gardner Automatic Color Difference Meter reflectance ratio a/b. Seasonal reflectance measurements on fruit samples indicate slightly higher coloration in the fruit from the sandy soil. Color declined and Brix: acid ratio increased as the season progressed.

1183. EFFECT OF BENZENE HEXACHLORIDE AND LINDANE ON THE FLAVOR OF PURPLE HULL PEAS. Wene, G. P.; Otey, G. W.; and Griffiths, F. P. Proc. Am. Soc. Hort. Sci. 64: 390-92. 1954.

Experimental plots of purple hull peas were variously treated with one dusting and three dustings 3 percent benzene hexachloride; one and three dustings 3 percent lindane, and three dustings 1 percent lindane. Peas were then canned, and flavor evaluated against an untreated control. Results indicated that use of lindane as an insecticidal dust on fields of purple hull peas did not result in an objectionable flavor carryover into processed peas. Processed peas from plots having either single or triple applications of commercial benzene hexachloride had a detectable off-flavor.

1179. FROZEN GRAPEFRUIT, TANGERINE, AND LIMEADE CONCENTRATES. Veldhuis, M. K.; Scott, W. C.; and Griffiths, F. P. Food Technol. 9: 198-201. 1955.

The principal properties and problems of frozen grapefruit, tangerine, and limeade concentrates are discussed. Grapefruit concentrates are somewhat lacking in stability, therefore heat treatment is used to improve cloud stability. Tangerines are fragile, irregular in shape, and present problems in juice extraction and finishing. Lime juice may be merely sweetened in the preparation of concentrate for limeade or more concentrated products may be prepared by evaporation under low pressure and reinforcement of flavor with puree. Satisfactory frozen concentrates have been commercially prepared from all three types of fruit. Results of laboratory analyses are given for nine samples of grapefruit, three of tangerine, and eight of limeade concentrates.

1119. RESEARCH INDICATES NEW TRENDS IN CITRUS PROCESSING. Griffiths, F. P. and Jones, M. A. In "Building the Citrus Industry of the Lower Rio Grande Valley." Published by United Citrus Growers, Pharr, Texas. 1954, pp. 21, 23.

A satisfactory method of processing pink and red grapefruit unsalable in the fresh state is the most pressing problem of the citrus canning industry in the Lower Rio Grande Valley of Texas. Two methods are being explored. Two other grapefruit products have been studied -- a frozen concentrate, and a concentrate to keep at temperatures of 40°F. or higher. Frozen limeade base also appears to have possibilities.

1120. PROCESSING CHARACTERISTICS OF COLORED TEXAS GRAPEFRUIT. I. COLOR AND MATURITY STUDIES OF RUBY RED GRAPEFRUIT. Lime, B. J.; Stephens, T. S.; and Griffiths, F. P. Food Technol. 8: 566-69. 1954.

To process juice from colored grapefruit successfully, more information was needed about the development of color, and its relation to maturity. The Ruby Red was selected for study because it is probably the most widely planted of the colored varieties in Texas. Measurements of color and of some chemical and physical characteristics were made at intervals of 2 weeks for about 8½ months. These measurements included visual and reflected color; average weight; Brix, acid, naringin, lycopene, and carotene content. Color was strongest early in the season, before fruit reached its peak of processing quality, and had begun to fade when this peak had been reached. These studies indicate that the combination of good color with high flavor characteristics is limited to a relatively short period.

1045. NOTES ON THE PROCESSING CHARACTERISTICS OF LIMES. Griffiths, F. P.; Lime, B. J.; and Stephens, T. S. Proc. Rio Grande Valley Hort. Inst. 8: 110-13. 1954.

Mexican limes of the same type as those grown heretofore in the Lower Rio Grande Valley, known as West Indian, Key, or Mexican limes, were processed. These experiments have shown that a satisfactory limeade base for freezing can be made from Mexican limes if careful extraction procedures are used. Addition of sugar to bring the Brix up to 60° - 65° gives a base which upon dilution with 5 volumes of water yields a limeade containing approximately 0.75 gram acid per 100 ml. and 12-14 percent sugar.

970. PAPAYAS IN THE RIO GRANDE VALLEY. Griffiths, F. P. Texas Farming & Citriculture 30(6): 4,24. 1953.

Trees bear fruit 12 to 18 months after planting. Papain may be obtained from the green fruit, but labor costs appear too high for profitable production in this area. Use of the green fruit as a vegetable and preparation of the ripe fruit for table use, or as frozen or canned puree or cubes, is described. A dried meal prepared from the leaves is used to some extent in animal feeds.

898. STABILIZATION OF GRAPEFRUIT CONCENTRATES -- A PROGRESS REPORT. Huffman, W. A. H.; Lime, B. J.; and Scott, W. C. Proc. Rio Grande Valley Hort. Inst. 7:106. 1953.
Also published in Proc. Assoc. Southern Agr. Workers 50: 142. 1953.

A report on studies in progress on methods of preparing a concentrate from Texas-grown grapefruit which will remain stable for 6 to 12 months when stored at 40°F. (4.4° C.) or higher. Possible stabilizing methods investigated to date, singly and in combination include: Pasteurization, filling and sealing concentrates under superheated steam; addition of terpeneless oil to enhance flavor and aroma of heat-treated concentrates, varying the degree of concentration; addition of chemical preservatives and antioxidants; and adjusting the Brix-acid ratio by the addition of citric acid and sugars.

899. PROCESSED JUICES FROM TEXAS RED AND PINK GRAPEFRUIT -- A PROGRESS REPORT. Huffman, W. A. H.; Lime, B. J.; and Scott, W. C. Proc. Rio Grande Valley Hort. Inst. 7: 102-05. 1953.

Preliminary results are encouraging for the preparation of canned single-strength pink grapefruit juice and pink frozen concentrates using the naturally occurring ingredients of the fresh fruit. It is practical to blend juice from white grapefruit with centrifuged juice from red or pink varieties, but this method does not capitalize on the natural pigmentation of colored citrus.

902. CHANGES IN PROCESSING METHODS TO AVOID DARKENING IN CANNED TEXAS VALLEY BEETS. Huffman, W. A. H.; Lime, B. J.; and Scott, W. C. Proc. Rio Grande Valley Hort. Inst. 7: 143-47. 1953.

Laboratory studies, together with observations of the general processing conditions found in several canning plants, indicate the need for changes in processing procedures and equipment to avoid darkening in canned beets. It appears that darkening can be reduced and probably held within acceptable limits by use of adequate steam exhaust. Quality of canned beets could also be improved by replacing iron equipment with stainless steel or other suitable material, and by more expeditious handling during processing.

769. IDENTIFICATION OF SUGARS IN "RIO SWEET" CANTALOUPES. Huffman, W. A. H. Scott, W. C.; and Lime, B. J. Proc. Rio Grande Valley Hort. Inst. 6: 83-86. 1952.

In work at the U. S. Fruit and Vegetable Products Laboratory, D-sucrose, D-glucose, and D-fructose were detected, by means of paper chromatography, as constituent sugars in "Rio Sweet" cantaloupe, a new, disease-resistant variety developed at Substation No. 15 of the Texas Experiment Station. Acid hydrolysis revealed no additional sugars. Aqueous extracts gave the same qualitative results as 80 percent alcoholic extracts.

NOTE

Papers in the following section were published prior to the organization of the Southern Utilization Research and Development Division, and in most cases reprints are no longer available. They are included, however, as a record of accomplishment by the U. S. Fruit and Vegetable Products Laboratory at Weslaco, Texas, and for the benefit of those who may wish to refer to them in the original publication.

INDUSTRIAL UTILIZATION OF CITRUS CANNERY WASTE. Scott, W. C. Citrus Leaves 28(7): 30, 32, 34. 1948.

For the United States as a whole, approximately half of the citrus crop is marketed as fresh fruit. Processing of the other half of the crop results in about 20 percent of the total tonnage being distributed as processed food products, such as canned juice and sections. The remaining 30 percent goes into byproducts, chiefly stock feed. In 1947 approximately 93 percent of all citrus cannery waste in Texas was converted to feed. Other citrus by-products included molasses, essential oils, pectin, alcohol, and feed yeast, but their production is so small as to have little effect on the economy of the industry.

PROCESSING AS AN ADDITIONAL OUTLET FOR CITRUS FRUIT. Scott, W. C. Proc. Rio Grande Valley Hort. Inst. 1: 73-76. 1946. Republished as OUTLINES OF CITRUS PROCESSING. Texas Farming & Citriculture 24(5): 4-5. 1947.

Growth of the citrus processing industry in South Texas is outlined, from 1930, when it was non-existent, and growers were forced to bury cull fruit at a cost of $2.50 per ton, to 1945-46, when canners paid more than $9 million for culls. Canned grapefruit juice accounted for most of this output, with blended orange and grapefruit juice the second. Canned sections are a popular item, but are packed in small quantities because of higher labor costs. Vacuum-concentrated frozen orange juice is said to be the best of the orange products so far developed. Grapefruit juice has not lent itself well to vacuum concentration, but the Weslaco laboratory is working on the problem. Stock feed, prepared by dehydration of solid waste from canning operations, is first among the byproducts in volume and dollar value. Essential oils and pectin are mentioned as other by-products of some value.

DEHYDRATION OF TEXAS-GROWN SNAP BEANS. Pentzer, D. J. Fruit Products J. 24(5): 1936-37, 1957. 1945.

This study was undertaken to determine the adaptability to dehydration of different varieties of snap beans as grown in the Rio Grande Valley of Texas. It was found that a blanch of 10 minutes in flowing steam was required to produce a product that was tender after subsequent dehydration. This blanch was longer than that required to inactivate the enzymes. Dipping the blanched beans in a solution of sodium bicarbonate before dehydration did not improve the color of the reconstituted dehydrated beans, but it did have a tenderizing effect. In testing 15 commercially and experimentally grown varieties, it was found that the Refugee variety gave the lowest quality rating of all varieties tested, while the Decatur and Blue Lake Stringless varieties gave the highest and second highest quality ratings, respectively. Beta-carotene content of these varieties followed the color and quality ratings in a general way, the deepest-green variety having the most carotene (53.7 ppm dry basis) and the lightest-green variety, the least carotene (20.1 ppm dry basis).

PRESERVATION OF PINEAPPLE WITH SULFUR DIOXIDE. Scott, W. C. and Pentzer, D. J. Fruit Products J. 23(7): 206, 213, 217. 1944.

Pineapple was found to be well preserved with sulfur dioxide, but not with sodium benzoate. When preserved with sulfurous acid the color and flavor were adequately maintained for test periods of eight weeks at 110°F. and for three months at room temperature. Addition of sugar at the time of crushing had no effect on the quality of the preserved product. Sulfur dioxide was readily removed from the crushed fruit. Twenty minutes of vigorous boiling was sufficient to reduce the sulfur dioxide content well below the point where it is readily detected by taste. Preservation of the fruit in large pieces is effective, but crushing is recommended for the conservation of shipping weight and space, and to allow ready removal of sulfur dioxide. Blanching pineapple to destroy enzymes is not recommended. Bromelin is slowly but steadily inactivated during storage.

SIGNAL PROGRESS WITH FRUIT AND VEGETABLE BYPRODUCTS. Anon. Texas Farming & Citriculture 21(4): 24. 1944.

History of the laboratory from its establishment in 1931 to the present is recounted. J. L. Heid was the first chemist in charge, and was assisted by W. C. Scott. Upon Heid's resignation in 1941 Scott became chemist in charge and D. J. Pentzer came from the Pacific Northwest as assistant chemist. Among accomplishments cited for the early years was the installation in 1934, largely through efforts of the Laboratory staff, of the first grapefruit juice canning plant using flash pasteurization; development of a method for quick determination of oil in citrus juices, adopted as the official method for use in all citrus-producing areas; and pretreatment for control of peel oil in grapefruit juice used in both Texas and Florida; and contribution to establishment of a feed industry utilizing citrus peel and pomace. During the war years work of the laboratory was concentrated on vegetable dehydration, and on development of formulas for sulfur dioxide preservation of fruit pulps for Lend-Lease. Several lines of research needing attention for the future are suggested.

DEHYDRATION RESEARCH AT THE FRUIT AND VEGETABLE PRODUCTS LABORATORY, WESLACO, TEXAS. Scott, W. C. Southern Canner and Packer 4(12): 9. 1943.

This is a report of a talk made before the Southern Dehydration Conference in Longview, Texas, Oct. 20, 1943, and summarizes the information contained in "Quality and Vitamin Content of Dehydrated Vegetables," No. 24 abstracted herein.

QUALITY AND VITAMIN CONTENT OF DEHYDRATED VEGETABLES. Scott, W. C. Quick Frozen Foods 6(4): 42, 44. 1943.

One or more season's work has been done on carrots, green beans, sweetpotatoes, beets, and onions. Imperator carrots, the variety most widely grown in South Texas, is second only to Nantes in

quality of the dehydrated product. Dehydrated and reconstituted Stringless Green Pod and Tendergreen varieties of green beans compared favorably with the canned product, and the quality of dehydrated sweet Bermuda onions was high. Contrary to ideas widely accepted, thorough tenderization of the vegetables is recommended to insure products which reconstitute properly, and are completely tender. Blanching times recommended are 20 minutes for carrots and sweetpotatoes, 12 minutes for Irish potato strips and green beans of No. 4 sieve size. They also recommend high initial temperatures at the lowest possible humidity for dehydration.

DEHYDRATION TESTS ON RIO GRANDE VALLEY CARROTS - 1942-43. Pentzer, D. J. and Wood, J. F. U. S. Dept. Agr., Bur. Agr. and Ind. Chem., Mimeo. Circ. AIC-30, 5 pp., processed. 1943. (Also issued as Texas Agr. Expt. Sta. Progr. Rept. 842, 1 p., processed. 1943).

Wartime demands turned attention of the Weslaco Laboratory to studies on dehydration of vegetables grown in South Texas, such as carrots. Eight varieties of carrots were used in the tests. Washed, topped carrots were lye-peeled, rinsed, and blanched for 20 minutes in flowing steam. Shorter blanches, while inactivating enzymes, were found to be insufficient to insure tenderness of the reconstituted product. The samples were then dehydrated to 8 to 10 percent final moisture content. The Nantes and Red Core Chantenay gave the best product, but the yield from the Nantes was comparatively low. Carrots harvested between 120 to 150 days after planting gave the best quality in the dehydrated product. Ascorbic acid assays showed retention best in the younger carrots.

PRETREATMENT OF GRAPEFRUIT FOR JUICE CANNING. Scott, W. C. Canner 93(18): 11. 1941.

Introduction of mechanical extraction into the grapefruit juice canning industry resulted in a problem of peel oil contamination. Such contamination might cause the quality of juice to vary from Grade A to Off-Grade in a single day's run. A method was developed for treating the whole fruit with steam or hot water prior to extraction; such treatments proved quite effective in reducing the recoverable oil in mechanically extracted juices. In a single test using boiling water for 60 seconds, the recoverable oil in juice extracted from Duncan fruit was reduced from 0.100 percent to 0.006 percent. Times and temperatures of treatment for different varieties of citrus are recommended.

THE FREEZING PRESERVATION OF CITRUS FRUITS AND JUICES. Heid, J. L. U. S. Dept. Agr., Bur. Agr. Chem. and Eng., Mimeo Circ. ACE-81, 6 pp., processed. 1941.

Frozen storage is reported to be an efficient means of preserving untreated citrus fruits and juices with minimum deterioration of flavor and quality. The author outlines preparation methods which have been found satisfactory. Great care in the harvesting

and preparation of the fruit is recommended. Only sound, mature fruit should be used, and rigid plant sanitation maintained. Juice should be extracted in such a manner as to minimize oil and other substances from the peel and rag. Detailed instructions are given for screening, sweetening and blending, filling, selection of containers, as well as storage, transportation, and preparation for use. Preparation of frozen orange and grapefruit sections is also described. Marsh and Duncan grapefruit varieties are said to be suitable for frozen juice; these varieties and pink or red variants for frozen sections. Valencia is said to be the best variety of orange for frozen juice, followed in order of preference by Temple, Hamlin, Parson Brown, and Navel.

DETERMINATION OF PEEL OIL IN GRAPEFRUIT JUICE. Scott, W. C. J. Assoc. Offic. Agr. Chemists 24: 165-70. 1941.

The adoption by the grapefruit juice canning industry of mechanical juice extractors has brought about the need for a method to measure the quantity of peel oil incorporated in the juice during extraction. Excessive quantities of peel oil in the juice impairs flavor and keeping qualities. A method for measuring the oil in the juice is described and illustrated. In principle, the method is steam distillation and recovery of the volatile oil in a receiver suitable for measuring a small quantity of oil lighter than water.

BY PRODUCTS LABORATORY AIDING VALLEY. UTILIZATION OF CROPS BY CANNING, FREEZING, DRYING INVESTIGATED. Heid, J. L. Mission Times (Seventh Ann. Texas Citrus Fiesta Edition) 31(15): 1, 5 (Sect. 6). Jan. 12, 1940.

The situation in regard to the processing of Texas-grown fruits and vegetables is discussed generally, with specific reference to developments on production of feed from citrus cannery residues; cannery waste disposal; and specialty products from citrus, vegetables, and subtropical fruits, such as the papaya. A large section of the paper is devoted to reports of investigations at the Laboratory into the freezing of vegetables grown in the area. Processing methods, suitable varieties, packaging, and other information of interest to commercial packers or freezers is presented in some detail, calling attention to information available at the Laboratory on this subject.

THE UTILIZATION OF FRUITS AND VEGETABLES IN THE RIO GRANDE VALLEY. Heid, J. L. Fruit Products J. 20(1): 17-19, 25; 20(2): 44-46, 54. 1940. U. S. Dept. Agr., Bur. Agr. Chem. and Eng., Mimeo. Circ. ACE-30, 9 pp., processed. 1940.

At the Fruit and Vegetable Products Laboratory at Weslaco, Texas, investigations are conducted on the utilization of Texas fruits and vegetables by canning, freezing, drying, fermenting, and recovery of byproducts; also upon the disposal of wastes and residues. In developing and demonstrating advantageous methods for using perishable crops the object is to provide growers with facilities for disposing of grades unsuitable for the fresh market,

and for stabilizing markets by diversion of surpluses. About 200,000 tons go through processing plants annually, largely as a result of the development of methods which produce a juice of desirable quality. A steam-jacketed, coiled and flattened tubular pasteurizer designed at the Weslaco Laboratory is pictured and described. Other developments for the improvement of juice quality and advantageous disposal of cannery waste are presented. Work on papaya products, grapes, strawberries, and vegetables, including corn, peas, tomatoes and carrots is reviewed. The second installment is devoted to freezing of fruits and vegetables. Necessity of careful selection and preparation of the raw material for freezing is stressed, and specific recommendations as to varieties and methods of processing for citrus juices, lima beans, snap beans, broccoli, and sweet corn are given.

THE PRESERVATION OF TEXAS FRUITS AND VEGETABLES IN FROZEN LOCKER STORAGE. Heid, J. L. U. S. Dept. Agr., Bur. Agr. Chem. and Eng., Mimeo. Circ. ACE-60, processed. 1940.
Also published as "Frozen Locker Storage Developed Here," Mission Times 32(16): 6-7 (Sect. 4). Jan. 17, 1941.

Suitable varieties of fruits and vegetables, whole, sliced, pulped, or in the form of juice, may be advantageously preserved, efficiently utilizing frozen locker storage. For best results, however, varieties must be selected for color, flavor, texture and adaptability for production and freezing under local conditions. General instructions about preparation, utensils, blanching, containers, use of sugar syrups or brine, conditions of storage and thawing, are given in detail. Specific instructions applicable to different vegetables and fruits, and recommendations as to varieties, are given.

FRUITS AND VEGETABLES IN THE RIO GRANDE VALLEY. Heid, J. L. Canner 90(18): 13-14. 1940.

Scope of the fruit and vegetable processing industry in the area is indicated by statistics. About 600,000 tons of grapefruit are produced annually, of which one-third is processed, producing the equivalent of five million cases of 24 No. 2 cans of juice and sections. Solid residue is converted into stock feed. Papayas are said to be a promising crop for the section, and processed products are suggested. Approximately 35 varieties of vegetables are grown, and 20,000 carloads shipped annually. Possibilities of frozen packs are explored, and packaging and varieties discussed.

CITRUS FRUIT PRODUCTS. Chace, E. M.; von Loesecke, H. W.; and Heid, J. L. U. S. Dept. Agr. Circ. No. 577, 46 pp. 1940.

A brief review of the status of the citrus-products industry, together with a statement of the composition of the common citrus fruits, is given, also a description in some detail of the commercial methods of preparation of citrus products. It may seem that

in some cases, for example, the production of the essential oils, the text is adequate. This is because most of the devices now in use are the results of long study and experimentation on the part of the owners, and it would be manifestly improper to divulge their trade secrets. Methods for canning juice and segments, for producing beverage material, wines and brandies, vinegar, pectin, marmalades and marmalade stock, jellies, candied peel, and essential oils are given. There is also a brief statement on the disposal of waste. This circular has recently been revised and reissued as Agriculture Handbook No. 98, "Chemistry and Technology of Citrus, Citrus Products, and Byproducts."

FREEZING FRUITS AND VEGETABLES IN THE SOUTHWEST. Heid, J. L. Refrig. Eng. 38(5): 286-88. 1939.

Advantages of frozen over fresh or canned fruits and vegetables are discussed. Maintenance of quality requires close attention to every stage of manufacture, storage, and distribution. Methods of preparation, freezing, desirable freezing temperatures, and various types of packaging are also described. Results of tests on the freezing of different varieties of citrus and vegetables grown in the Southwest are discussed in detail.

NOTES ON SOME FACTORS AFFECTING THE QUALITY OF CANNED GRAPEFRUIT JUICE. Heid, J. L. and Scott, W. C. U. S. Dept. Agr., Bur. Chem. and Soils-52, processed. 1939.

Forms of deterioration which may cause losses to commercial canners of grapefruit juice include: separation and clotting; darkening and staling; and development of rank, bitter, or terpeny flavors. Small quantities of peel oil in the juice contribute to the characteristic grapefruit flavor, but excessive quantities tend to develop a rank, terpeny flavor during prolonged or unfavorable storage. Heavy pressing or grinding during extraction or screening may result in the incorporation of excessive sediment, naringin, pectin and pectic enzymes, with deleterious effect. Excessive pectin and pectic enzymes may cause clarification, clotting, curdling, or jellying. Pectic enzymes may be inactivated by heating, but when present in excessive quantities the time and temperature necessary to entirely inactivate them will impair the flavor of the juice. High storage temperatures and excessive headspace in the cans are also injurious to quality.

TEXAS FRUIT AND VEGETABLE JUICE PRODUCTS. Heid, J. L. Canner 88(25): 16-17; (26): 16-17, 28. 1939.

Early work of the Weslaco Laboratory in the development of the citrus canning industry is reviewed. Production of juice and other products from vegetables is surveyed; recent work of the Laboratory on the production of juices from Texas-grown carrots, tomatoes, and other vegetables is reported. Preparation of feed from dehydrated cannery residues, such as from citrus, tomatoes, and other vegetables is discussed. Yeast fermentation for disposal of liquid cannery waste has been introduced and is being practiced.

THE USE OF CITRUS POMACE IN MAKING IMITATION JAMS. Heid, J. L. Canner 87(6): 26. 1938.

Formulas are given for the preparation of four specialty products from the citrus pulp remaining after extraction of the juice for canning. The formulas are for commercial-scale operations, and include a plain jam, spiced jam, spiced butter, and blended jam.

PROCESSING SOUTH TEXAS FRUITS AND VEGETABLES. Heid, J. L. Texas Farming & Citriculture 15(6): 12-13. 1938.

Growth of the grapefruit juice canning industry from $10,000 in 1934-35 to $1,200,000 in 1937-38 is reported with a review of the part played by the Laboratory in this growth. Investigations on vegetable processing have been authorized, and freezing tests on English peas, lima beans, green beans, broccoli and corn are reported. The paper includes a recipe for grapefruit butter.

THE WORK AT THE CITRUS PRODUCTS STATION. Heid, J. L. Texas Farming & Citriculture 13(11): 4, 22. 1937.

At the time the U. S. Citrus Products Station in Weslaco began its work no citrus products plants were operating. Three plants began operation in 1933-34, paying approximately $10,000 for cull fruit; during the 1935-36 season 17 plants paid $70,000 for 25,000 tons of grapefruit. The laboratory investigated and recommended methods of reaming, screening, deaeration and flash pasteurization, and assisted in the designing and installation of plant equipment. Other work included developments on marmalade and marmalade base, grapefruit juice and pulp preserved with sulfur dioxide, grapefruit vinegar, alcoholic beverages, concentrates, frozen juices, and other products. Vegetable processing investigations, particularly on freezing, are mentioned.

THE PROCESSING OF CITRUS JUICES - OBSERVATIONS ON HEATING AND COOLING OPERATIONS. Heid, J. L. and Scott, W. C. Fruit Products J. 17(4): 100-04, 121. 1937.

Heating and cooling operations on citrus juices in seven commercial canning plants were observed and data are given. These data bear out conclusions previously reported by the authors that the velocity of juice flow in tubular heaters is an important factor in determining the rate of heat transfer. Other factors in the operation of various types of equipment are also reported in detail. Formation of juice deposits capable of interfering with heat transfer through tube walls was not observed when juice velocities were maintained in excess of eight feet per second, provided the flow of juice was directed upward through tubes to avoid air pockets, and juice was flushed from the heater with water when operations were suspended.

THE CAPACITY OF FLATTENED TUBE JUICE PASTEURIZERS. Heid, J. L. and Scott, W. C. Fruit Products J. 16(5): 136-39. 1937.

Steam-jacketed tubular beaters offer a rapid, inexpensive method for heating liquid foods; flattening of the tube reduces cross sectional area, increases velocity, and minimizes dependence upon conduction of heat through layers of juice. Rapid, uniform heating and cooking is necessary to prepare citrus juice of good flavor and keeping quality. Factors affecting the heat transfer rate in tubular juice pasteurizers include: velocity and agitation of the juice; material and thickness of the tube; circulation of steam and removal of condensate; specific heats of juice and steam; temperature differences; initial, final, and average. Performance data on straight and coiled tubular juice pasteurizers are cited, and calculations made for pertinent data.

CITRUS PRODUCTS, 1934. Heid, J. L. Proc. Texas Citrus Inst. 3: 27-30. 1934.

The importance of citrus products in the development of a healthy citrus industry is described, and the need for research to develop such products is outlined.

MARMALADE STOCK AND MARMALADE (Mimeo. Sheet). Scott, W. C. and Heid, J. L. Texas Citriculture 10(9): 18. 1934.

Instructions are given for the preparation of marmalade stock from whole grapefruit, or from grapefruit with shredded peel. This stock may be canned in sealed containers and kept indefinitely. Instructions are given also for making the stock into marmalade. A recipe for calamondin marmalade is included. A machine for shredding the peel on the grapefruit is described.

OUTLOOK FOR CITRUS PRODUCT MANUFACTURE IN TEXAS. Heid, J. L. Texas Citriculture 9(9): 8. 1933.

Work of the newly established citrus research laboratory is outlined. It has been found that if juice from thoroughly mature fruit is properly extracted, deaerated, processed, and packed under scrupulous control, the product is highly palatable, and keeps well. Staff scientists are also cooperating with the Texas Department of Agriculture on a study of citrus maturity; they are investigating the preparation of grapefruit marmalade, and the use of waste from canning plants as a source of humus for farm lands.

CITRUS PRODUCTS INVESTIGATION IN TEXAS. Heid, J. L. Texas Citriculture 8(8): 12-13. 1932.

Need of the newly-established citrus industry of South Texas for a byproducts industry is outlined. Such an industry would bring additional income to growers, and provide an outlet for surplus or cull fruit. Growth of the canning industry is cited, and other avenues of exploration are suggested, such as quick freezing of juice and sections, marmalade, candied peel, peel and seed oil, pectin; bioflavonoids; and stock feed from the residual peel and pulp.

A U T H O R I N D E X

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